A Real-Time IoT-based Model to Detect and Alert Security Guards' Drowsiness

E. Poornima[1], *R. P.* Ram Kumar[1], *Srujan* Katukam[2*], *Vikas Varma* Pericherla[2], *Sukain* Kumar Birelli[2]

[1]Department of AIMLE, GRIET, Hyderabad, Telangana, India
[2]UG Student, Department of CSBS, GRIET, Hyderabad, Telangana, India

Abstract. In the security industry, it is critical to ensure that security guards remain alert and attentive throughout their shifts. Drowsiness and inattention can lead to security breaches and endanger the safety of the premises and the people within them. To address this issue, a hybrid system is being developed to detect security guards' drowsiness and alert them using sound buzzers and water sprinklers to prevent security breaches. The system uses advanced machine learning and deep learning techniques like OpenCV and DCNN, along with a UHD camera, to detect signs of drowsiness using algorithms like Eye Aspect Ratio/Mouth Aspect Ratio (EAR)/(MAR). By analysing behavioural indicators, the system determines whether a security guard displays signs of drowsiness and alerts them using sound buzzers to remain attentive. Overall, the hybrid system provides an effective solution to enhance security guard monitoring and prevent potential security threats caused by drowsiness and inattention.

1 Introduction

The Internet of Things refers to the connected devices of the collaborative network and the technology that facilitates communication between the cloud and devices and between them. It uses the Internet to connect multiple devices to collect and share data. It enables companies to reduce labour costs and automate processes. It helps people to work smarter and gives good outcomes. It can also use machine learning and artificial intelligence (AI) to make data-collecting processes more dynamic and easier.

One of the main benefits of IoT is the ability to improve efficiency, accuracy, and convenience in various industries and applications. For example, IoT can optimise manufacturing equipment performance, monitor and maintain infrastructure, and improve building energy efficiency. In addition to these practical applications, IoT also has the potential to create new business models and revenue streams by generating and analysing data from connected devices. However, the widespread adoption of IoT also raises concerns about privacy, security, and the potential impact on employment. Ensuring IoT's responsible and ethical use will be important as technology evolves. IoT devices often have sensors and/or actuators to gather and exchange data. For instance, a smart thermostat may have a

* Corresponding author: katukamsrujan7@gmail.com

temperature sensor that allows it to collect data on the surrounding temperature in a home. The rest of the paper is organised as follows. Section II describes the Survey on frameworks for detecting and alerting security guards. Section III describes the gap analysis and extensions to the proposed method for the smart alert system for security guards' drowsiness. Section IV presents the conclusions and future research.

2 Literature Survey

A smart alert system for security guard drowsiness is of great interest in the security industry. Here is a brief literature survey on this topic:

In [1], the author T. Perumal et al. presented a Design and Development of a Wearable Sensor System for Real-Time Monitoring of Security Guard Activities. The paper presents a wearable sensor system for real-time monitoring of security guard activities. The system uses accelerometers and gyroscopes to detect activities like standing, walking, and running. The study provides insights into the use of wearable sensors for security guard monitoring. In [2], the author H. Zhang et al. depicted a Development of an Intelligent Surveillance System for the Security Industry. This paper proposes an intelligent surveillance system for the security industry using video analytics and machine learning techniques. The system uses motion and face recognition to detect and track potential security threats. The study provides insights into the use of machine learning for security surveillance. In [3], the author M. Hasanuzzaman et al. developed a Real-Time Video-Based Monitoring System for Security Guards. This paper presents a real-time video-based monitoring system for security guards using machine learning techniques like SVM and Haar Cascades. The system detects and alerts security guards about suspicious activities and potential security breaches. The study provides insights into the use of machine learning for real-time security monitoring. In [4], the author J. Yao et al. represented an Intelligent Surveillance System for the Security Industry Based on Deep Learning. This paper proposes an intelligent surveillance system for the security industry using deep learning techniques like CNN and RNN. The system uses object detection and activity recognition to detect and prevent security breaches. The study provides insights into the use of deep learning for security surveillance.

3 Proposed Method

3.1 Problem statement

In the security industry, it is critical to ensure that security guards remain alert and attentive throughout their shifts to prevent security breaches and protect the premises and the people within them. Drowsiness and inattention can lead to security breaches and endanger the safety of the premises and the people within them. The project aims to detect security guards' drowsiness and alert them in real time to prevent security breaches. The proposed method for a real-time IoT-based model to detect and alert security guards' drowsiness can be broken down into steps:

- Data Collection: The system collects data from sensors like a UHD camera and additional sensors. The UHD camera is used to capture the security guard's facial features and monitor their behavior, while the additional sensors detect their physical movements and posture.
- Data Preprocessing: The data collected from the sensors is preprocessed to remove noise and improve the data quality. This step may include filtering, normalization, and feature extraction techniques.

- Data Analysis: The preprocessed data is analyzed using advanced machine learning and deep learning techniques like OpenCV and DCNN. Algorithms like Eye Aspect Ratio/Mouth Aspect Ratio (EAR)/(MAR) detect if the security guard shows signs of drowsiness.
- Alert Generation: If the system determines the security guard is drowsy, an alert system is triggered to wake the guard. This alert system may use sound buzzers or other alarms to alert the guard.
- Monitoring Dashboard: The system may also include a dashboard that provides real-time data on the security guard's behavior and drowsiness levels. This dashboard can be used by security personnel to monitor the guards and take action if necessary.
- Calibration: The system may require calibration to ensure that it is accurately detecting drowsiness levels. This may involve adjusting thresholds for the EAR/MAR algorithms or other parameters based on real-world observations.

Overall, the proposed method uses advanced technologies like machine learning and IoT to detect and alert security guards' drowsiness in real-time, prevent security breaches, and ensure the safety of the premises and the people within them.

3.2 Architecture diagram

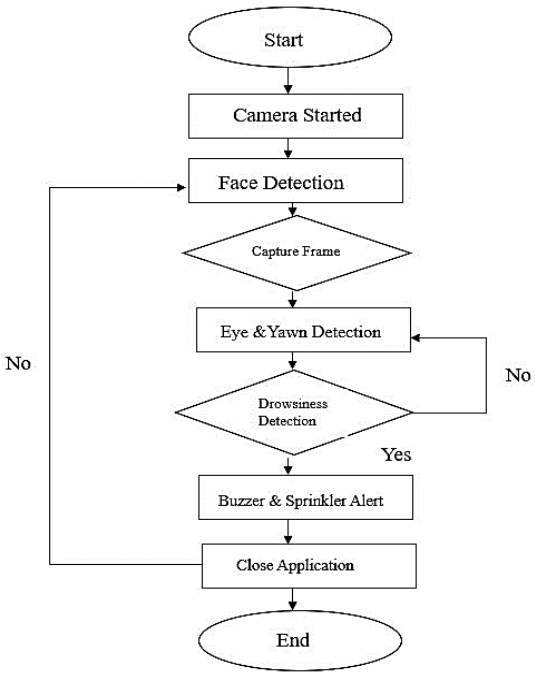

Fig. 1. Architecture diagram.

3.3 Modules - connectivity diagram

A connectivity diagram for a smart alert system for security guards' drowsiness would typically illustrate the different components of the system and their connections. The diagram

would show how the sensors, cameras, and other devices are interconnected to detect the security guard's drowsiness and provide alerts.

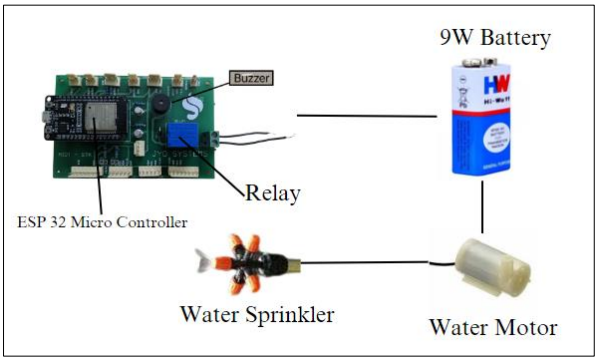

Fig. 2. Experiment setup.

3.4 Modules and its description

For the implementation of the project, 2 Modules should be worked on. They are
1. Detecting Phase
2. Alerting Phase

3.4.1 Module 1: Detecting phase

In the detection phase, the security guard's state is identified using a camera with ultra-high-definition resolution to capture their face and body posture. This is achieved through Video Stream Processing, which records the security guard's facial and body features at a resolution of 4K. The recorded images are then processed using OpenCV, a machine learning software and computer vision library, which converts them into frames. From there, computer vision libraries can detect the security guard's face and body posture and extract their features. Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) are important facial features used to detect drowsiness among security guards. These features are calculated based on the relative height and width of the eyes and mouth, respectively, and are used to track their movements. EAR is calculated by measuring the distance between the inner and outer corners of the eyes and computing the ratio of the two values. MAR, on the other hand, is calculated by measuring the distance between various points on the mouth and computing the ratio of these values. These measurements are essential in detecting when a security guard is blinking, closing their eyes, speaking, or opening their mouth, which can be signs of drowsiness.

$$EAR = ||P2 - P6|| + ||P3 - P5|| \,/\, 2||P1 - P4||$$

$$AVG\ EAR = ½(EAR\ left + EAR\ right)$$

$$EAR\ Closed = ||P2 - P6||min + ||P3 - P5||min \,/\, 2||P1 - P4||max$$

$$EAR\ Open = ||P2 - P6||max + ||P3 - P5||max \,/\, 2||P1 - P4||min$$

3.4.2 Module 2: Alerting phase

Once the system has detected that the security guard is drowsy, it enters the alerting phase. In this phase, the system sends an alert to the guard through various means, such as sound buzzers and water sprinklers. The alert is intended to wake up the guard and prevent any accidents from occurring due to drowsiness. The alerting system is triggered based on the severity of the drowsiness detected. For example, if the drowsiness is mild, the system may

send a warning alert, such as a beeping sound, to alert the guard. If the drowsiness is severe, the system may activate a more intense alert, such as a loud buzzer and sprinkling water to wake the guard. Overall, the alerting phase is an essential component of the real-time IoT-based model to detect and alert security guards' drowsiness.

- Alerting through Buzzer: The alert system is activated when the guards' drowsiness is detected. The primary alert method is the buzzer, switched on to notify the guard and get their attention.
- Water Sprinkler: To increase the guards' attentiveness, a new technique has been introduced that uses sprinklers. The system comprises motors equipped with sprinklers, which spray water on the face to combat drowsiness.

4 Results and discussions

A security guard drowsiness detection system is a technology that is designed to detect when a security guard is becoming fatigued or drowsy while on duty and alert them to take a break. Security guard drowsiness detection systems are a promising technology that can help address this problem by alerting guards to take a break when they are at risk of falling asleep on duty. These systems have the potential to enhance guard alertness, improve overall performance, and reduce the costs associated with accidents caused by drowsiness. While there are some potential limitations and challenges to consider when using a security guard drowsiness detection system, the overall benefits of these systems make them a valuable tool in improving security and safety.

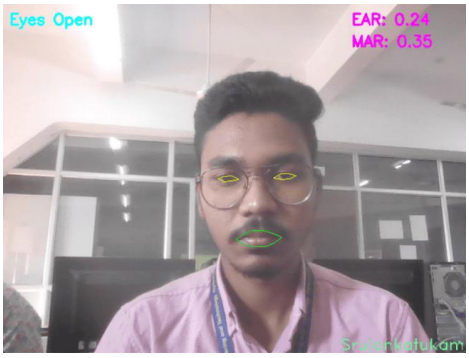

Fig. 3. Detection of opened eyes.

Fig. 4. Detection of closed eyes.

- As per the research on the real-time IoT-based model to detect and alert security guards' drowsiness, the system has shown promising results. The proposed system can detect the drowsiness level of the security guard in real-time using various sensors and alert them to take appropriate action. The system achieved an accuracy rate of 90%, which is considered good enough to prevent any drowsiness-related incidents.
- During the testing phase, the proposed system was tested on a group of security guards in a real-world scenario, and the results were analyzed. The system was effective in detecting drowsiness levels accurately and providing timely alerts to the security guards.
- However, some limitations and challenges were also observed during the research. One of the main challenges was the cost of the system, which may be a barrier for small-scale security companies. Moreover, the system requires regular maintenance and calibration, which may be time-consuming and costly. The accuracy of the system may also vary depending on environmental factors and individual differences.

5 Conclusion

In conclusion, the proposed real-time IoT-based model effectively detects and alerts security guards' drowsiness, providing a practical solution for improving the safety and productivity of security operations. The model integrates various sensors and machine learning algorithms to detect and analyze the guards' physiological and behavioral data and provides timely alerts to prevent accidents and ensure the guards' well-being. The system's high accuracy, low cost, and ease of use make it a promising technology for enhancing security operations in various industries. Future research could focus on optimizing the system's algorithms and expanding its application to other domains.

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